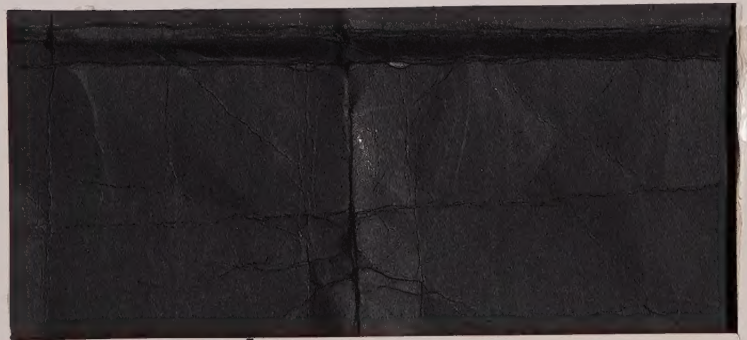


**REGULATED
POWER
SUPPLIES**

SERVICE



HARRISON LABORATORIES, INC.

45 Industrial Road • Berkeley Heights • New Jersey



The information contained in this booklet is intended for the operation and maintenance of H-Lab equipment and is not to be used or otherwise reproduced without written consent of the Harrison Laboratories, Inc.

Harrison Laboratories, Inc.

45-53 Industrial Road
CRestview 3-9123

Berkeley Heights, New Jersey
TWX Summit, N. J. 977

Model 865

8654

Power Supply

Instruction & Operating Manual

WARRANTY

Harrison Laboratories, Inc. warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replacing any defective parts thereof; electron tubes, transistors, fuses, and batteries are specifically excluded from any warranty. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. Our warranty for this instrument is rendered void if the unit has been modified, unless such changes have been made in accordance with written instructions received from Harrison Laboratories, Inc. If the fault has been caused by misuse or abnormal conditions of operation or results from use in combination with any other items, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

- A. Notify us, giving full details of the difficulty, and include the model number and serial number of the equipment. On receipt of this information, we will give you service data or shipping instructions. Do not return unit for repair without first contacting factory or sales representative for instructions.
- B. On receipt of shipping instructions, forward the instrument prepaid to the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.
- C. If the original carton and packing are not available, the instrument should be packed in a strong exterior container and surrounded by two or three inches of excelsior or similar shock-absorbing material. We advise that all returned equipment should be declared at full value to the carrier.

Harrison Laboratories, Inc. reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of Harrison Laboratories, Inc. and Harrison Laboratories, Inc. neither assumes nor authorizes any other person to assume for it any liability in connection with the sales of Harrison Laboratories, Inc. instruments.

PATENT NOTICE

Patents have been applied for circuits used in this power supply. Buyer is not licensed to reproduce drawings or to utilize the circuit without written permission from Harrison Laboratories, Inc.

CLAIM FOR DAMAGE IN SHIPMENT

This equipment should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition which is to be made of the equipment and arrange for repair or replacement.

WARRANTY

Harrison Laboratories, Inc. warrants each instrument manufactured by this company to be free from defects in material and workmanship. Our liability under this warranty is limited to repairing or substituting any instrument returned to the factory for that purpose and to refunding any defective parts, factory stores, etc. This warranty is effective for one year after delivery to the original purchaser. When the instrument is returned, transportation charges prepaid by the original purchaser, and when upon examination it is determined to our satisfaction to be defective, our warranty for this instrument is voided if the unit has been modified, unless such changes have been made in accordance with written instructions received from Harrison Laboratories, Inc. If the unit has been caused by misuse or abnormal conditions of operation or results from use in connection with any other items, repairs will be billed as extra. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

A. Promptly call the following toll-free number, and include the model number and serial number of the instrument. On receipt of the information we will give you service data or shipping instructions. Do not return unit for repair without first consulting factory or sales representative for instructions.

B. On receipt of service data or shipping instructions, return unit to the factory. If the instrument is not covered by the warranty, a charge for the unit will be made.

C. If the original owner and operator are not available, the instrument should be packed in a strong exterior container and surrounded by two or three inches of excelsior or similar shock-absorbing material. The owner must fill returned equipment and it be declared at full value to the carrier.

Harrison Laboratories, Inc. reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly limited to all other warranties or limitations on the part of Harrison Laboratories, Inc. and Harrison Laboratories, Inc. neither assumes nor authorizes any other person to assume for it any liability in connection with the sales of Harrison Laboratories, Inc. instruments.

PATENT NOTICE

Patents have been applied for claims used in this power supply. Buyer is not licensed to reproduce drawings or to utilize the circuit without written permission from Harrison Laboratories, Inc.

CLAIM FOR DAMAGE IN RETURN

A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition which is to be made of the equipment and arrange for repair or replacement.

https://archive.org/details/manualsplus_11320

The power switch S2 has an auxiliary set of contacts which short the output terminals when the supply is turned off. This switch and inherent design considerations prevent output voltage overshoot on turn-off and turn-on.

*PATENT NOTICE - Patents have been applied for circuits used in this power supply. Buyer is not licensed to reproduce drawings or to utilize the circuit or any part of the circuit without written permission from Harrison Laboratories, Inc.

Maintenance

Access to Printed Circuit Board--To gain access to the printed circuit board for the power supply, it is necessary to remove the two screws located near the rear of the case and then slide the case away from the rest of the supply.

Notice that several numbered points are identified on the printed circuit board and on the schematic. These corresponding numbers should facilitate any circuit testing which may be necessary.

Trouble Shooting

Nodal Check

As an initial check, the following are nodal voltages as measured on a Simpson Model 269 multimeter or equivalent. Set line voltage at 117 volts, output voltage at 40V, and apply full load (i.e., 0.5A).

<u>4 to -</u> <u>Voltage Between</u>	<u>Voltage Reading</u>	<u>Comments</u>
6 to 1	2.4 volts	If above 2.7 volts check diodes
18 to 17	1.2 "	" " 1.5 " " "
13 to 12	2.4 "	" " 2.7 " " "
7 to 13	0.7 "	≠ 0.2 volts
1 to 20	9.5 "	Should range between 9.2 & 9.8
20 to 19	2.0 "	≠ 15%
1 to 11	13 "	≠ 5 volts
1 to 17	15.0 "	≠ 2 volts
1 to 15	36 "	≠ 4 volts
3 to 20	9.5 "	≠ 10%
2 to 11	50.6 "	≠ 2 volts
23 to 25	2.4 "	≠ .3 volts
1 to 7	0.5 "	≠ 0.1 volts
7 to 14	45 "	≠ 5 volts

MODEL 865
POWER SUPPLY

Specifications

Input:

105 to 125 volts, 50-440 cycles, single phase.

Output:

0-40 volts at 0.5 amperes

Load Regulation:

Less than 5.0 millivolts change in output voltage from no load to full load. This specification holds for any output voltage and any line voltage within the rating of the supply.

Line Regulation:

Less than 5.0 millivolts change in output voltage for a change in line voltage from 105 to 125 volts. This specification holds for any output voltage and any load current within the rating of the supply.

Ripple and Noise:

Less than 500 microvolts rms for any combination of line voltage, output voltage, and load current (as measured with a Hewlett-Packard 400D voltmeter).

Maximum Ambient Operating Temperature: 50°C.

Temperature Coefficient:

Output voltage change per degree centigrade is less than 2.0 millivolts.

Stability:

The total drift for 8 hours (after 20 minutes warm-up) at a constant ambient is less than 30 millivolts.*

Internal Impedance:

Less than .005 ohms from DC to 100 cycles.
Less than .02 ohms from 100 cycles to 1.0 Kc.
Less than .5 ohms from 1 Kc to 100 Kc.
Less than 3.0 ohms from 100 Kc. to 1 Mc.

Transient Recovery Time:

Less than 75 microseconds is required for output voltage recovery to within 5 millivolts of the nominal output voltage following a 0.5 ampere change in output current. For this measurement, nominal voltage is defined as the mean between the no load and full load voltages.

*Using precision wire wound remote programming resistor or rheostat.

Overload Adjustable Protection:

An all-electronic, continuously acting, current-limiting circuit protects the power supply for all overloads, including a direct short across the output terminals.

Controls:

A single coarse control makes possible continuous adjustment of the output voltage for the entire output voltage range. In addition a vernier control provides an output voltage change of approximately 2 millivolts per degree of rotation. A third front panel knob permits adjustment of the overload current limit from approximately 25 to 550 ma.

Meter:

A single meter and meter switch make possible the monitoring of either output voltage or output current.

Output Terminals:

"Five way" output binding posts are provided on the front panel. Power supply output terminals are isolated from the chassis, and either the positive or negative terminal may be connected to the chassis through a separate ground terminal located adjacent to the output terminals.

Remote Programming:

Remote programming of the supply output voltage at approximately 100 ohms/volt is made available on a rear terminal strip.

Cooling:

Convection cooling is employed. The supply has no moving parts.

Size:

8"W x 5 1/16"H x 8"D (mounted in case)

Weight: 11 pounds

Finish: Light Gray Panel; Dark Gray Case.

Operating Instructions

Inspection

This instrument was thoroughly tested and inspected before being shipped and is ready for use when received.

After the instrument is unpacked, it should be inspected for damage received in transit. If any shipping damage is found, follow the procedure outlined in "Claim For Damage In Shipment" on page 1.

Putting Supply into Service

The Model 865 supply can be used in a C-855/865 case or mounted on an R-855/865 rack mounting panel. If the 865 is to be used in conjunction with the rack mounting panel, sufficient hardware to mount two supplies will be found with each panel.

Controls and Terminals.

The toggle switch near the lower left edge of the front panel controls the power supplied to the equipment from the power line. The indicator lamp beside the switch, when lighted, indicates that AC power is applied to the transformer primary.

Fuse - The fuseholder is located on the rear of the power supply and contains a one ampere 3 AG fuse for the protection of the entire instrument. This fuse is not intended to provide the output overload protection. An automatic output overload circuit is used for this purpose and thereby protects the series transistors.

Controls - The control marked "Voltage Adj." provides a continuous adjustment of the output voltage. A small vernier knob is concentrically mounted with the larger main voltage adjust knob. This fine control permits a fine adjustment of the output voltage and has a 0.5 volt range over the 270° of pot rotation. The "Max. Current - Ma!" knob permits the maximum

output current to be limited to approximately the value indicated on the front panel scale associated with this knob. For a more exact setting of this control the output terminals should be shorted; the ammeter then indicates directly the current limit value.

Terminals - On the front panel are located three binding post terminals. The output power is obtained from the binding posts marked "+/-" and "-". The binding post designated "ground" is a chassis ground, and either the plus or minus post may be grounded to the chassis.

Remote Programming - As shipped from the factory each 865 is wired for output voltage control utilizing the two concentric front panel knobs. If the remote programming mode of operation is to be employed, the strap between 3 and 29 on the rear terminal strip must be removed. The output voltage of this supply will then be determined by the value of resistance connected between terminals 2 and 3 and will be one volt for each 100 ohms of resistance connected between these terminals. The remote programming terminals should be used if optimum performance with regard to temperature coefficient and stability is desired. High quality, low temperature coefficient wire-wound programming resistors and rheostats will permit the low noise and drift capabilities of the 865 to be fully realized. Several modes of remotely controlling the output voltage are possible:

- (1) A 4000 ohm rheostat can be placed across the programming terminals; the output voltage will then be continuously variable from 0 to 40 volts.
- (2) A single resistor can be used as the programming element thereby fixing the output voltage at some predetermined value.
- (3) Several resistors can be connected to a switch, so that the output voltage can be changed from one predetermined value to another with the assurance that any of the preset values can be accurately reproduced at a later time if desired.

(4) A resistor and a rheostat can be arranged in series so that the output voltage will be variable, but only over a narrow range. For example, a 200 ohm rheostat in series with a 2900 ohm resistor would allow the output voltage to be varied from 29.0 to 31.0 volts.

Series Operation

Two or more 865's can be combined in series to obtain a voltage higher than that available from one supply alone, or to obtain a "chain" of regulated voltages. There are several methods by which these supplies can be connected in series. The simplest means consists of placing the output terminals in series, and allowing each supply to be individually controlled by its own front panel control (or remote programming control). This method has the obvious disadvantage that the total output voltage is not continuously adjustable over the entire range by means of one knob. To overcome this shortcoming, four alternate modes of series connection may be used, as described below: Simplified schematics for these four modes are given in Figure 3 (toward the back of the instruction manual).

Mode 1.

In this connection two supplies are connected in series and their outputs controlled by 2 ganged remote-programming pots.

A. Connect the positive output terminal of Supply 1 to the negative output terminal of Supply 2.

B & C. Wire 2 ganged pots to the programming terminals (2 & 3) of the rear terminal strips for the two supplies.

This mode of operation could be iterated to include any number of supplies in series, the only difficulty being the practical problem of ganging more than two pots.

Mode 2.

This connection avoids the use of ganged pots, and allows control from the front panel knob of one supply, the second supply output voltage being made to track that of the first supply.

- A. Connect a resistor R_x from the negative output terminal of Supply 1 to terminal 3 of Supply 2.
- B. Strap the positive output terminal of Supply 1 to the negative output terminal of Supply 2.
- C. Remove R_4 and R_{4A} on Supply 2.
- D. Strap terminal 3 to terminal 29 on the rear terminal strip of Supply 2.
- E. Strap terminal 3 to terminal 29 on Supply 1, or if remote control is desired, connect the remote programming resistor between terminals 2 and 3 of Supply 1.
- F. Set front panel control pot on Supply 2 to obtain the desired ratio of output voltage of Supply 2 to Supply 1.

This configuration is useful only for connecting two supplies in series. Where it is desired to connect three or more supplies in a manner similar to the above, the procedure of Mode 3 should be followed. Note that one advantage of the Mode 2 and Mode 3 connections is that the ratio of the "bottom" supply voltages to the "top" supply voltage can be set using the front panel controls on the "bottom" supplies; once set, these ratios remain constant as the total output voltage is varied by means of the main output control on the "top" supply.

Mode 3.

This method of connection is an extension of the Mode 2 configuration to three supplies in series. To extrapolate this to N supplies in series, it would be necessary to include a total of (N-2) supplies wired in the manner identical to that shown for Supply 2.

- A. Strap the positive output terminal of Supply 1 to the negative output terminal of Supply 2.

- B. Strap the positive output terminal of Supply 2 to the negative output terminal of Supply 3.
- C. Connect a resistor R_x from the negative output terminal of Supply 1 to terminal 3 on Supply 2.
- D. Remove R_4 and R_{4A} from Supply 2.
- E. Strap 3 to 29 on the rear terminal strap of Supply 2.
- F. On Supply 2, disconnect the wire leading from P1 to the positive output terminal. Instead, connect the freed end of P1 to terminal 3 on Supply 3.
- G. Remove R_4 and R_{4A} from Supply 3.
- H. Strap 3 to 29 on Supply 3.
- I. Strap 3 to 29 on Supply 1 for front panel control, or connect a remote programming control between terminals 2 and 3 of Supply 1.
- J. Set front panel control pots on Supplies 2 and 3 to obtain the desired ratios of output voltages of Supply 2 to Supply 1 and of Supply 3 to Supply 1.

Note that, as in Mode 2, the control for Supply 1 becomes a master control which will control the total output voltage over its entire range.

Mode 4.

Where it is not necessary to vary the ratio of the output of Supplies 2 and 3 to that of Supply 1, it is possible to use this fourth configuration. The advantage of the Mode 4 wiring lies in the fact that it is not necessary to unsolder the lead from the positive output terminal of Supply 2 to P1. This configuration may be used for two supplies in series by eliminating Supply 2 or may be extrapolated to N supplies in series by including a total of (N-2) supplies wired in the manner identical to that shown for

Supply 2.

- A. Connect the positive output terminal of Supply 1 to the negative output terminal of Supply 2.
- B. Connect the positive output terminal of Supply 2 to the negative output terminal of Supply 3.
- C. Connect a resistor R_x from the negative output terminal of Supply 1 to terminal 3 of Supply 2.
- D. Connect a resistor R_y from terminal 3 of Supply 2 to terminal 3 of Supply 3.
- E. Connect a resistor R_z from terminal 3 of Supply 3 to terminal 2 of Supply 3.
- F & G. Remove resistors R_4 and R_{4A} from Supplies 2 and 3.
- H & I. Be sure there are no straps connecting terminals on the rear terminal strips of Supplies 2 and 3.
- J. Strap terminals 3 to 29 on Supply 1 if it is desired that the front panel knob of Supply 1 control the total series output voltage, or connect a remote programming control between terminals 2 and 3 of Supply 1 if remote control of the system is desired.

For all four of the above modes, the values of resistors to be used can be determined using the equations shown in Figure 3. It is suggested that for all modes, the current through the R_x , R_y , and R_z should be approximately 10 milliamps, i.e., the values of R_x , R_y , and R_z selected should be approximately 100 ohms for each output volt desired.

Parallel Operation

Parallel operation of two low resistance sources is normally impossible because of the large circulating current which will result from even a small difference in the output voltage of the two sources. However, the 865 has provision for slave operation, wherein one supply

(the master unit) controls its own output and that of another supply (the slave unit) whose output terminals are connected in parallel with those of the master supply. Remove Q4 of the slave unit from its socket and strap terminal 10 on the rear terminal strip of the master unit to terminal 10 on the slave unit. Due to the natural unbalance of the series regulating transistors, the current from each supply should be checked while in parallel operation. In general, it is not advisable to provide a total load of more than 0.9 amperes for two 865's connected for slave operation.

Power Supply Measurements

When measuring the output impedance, transient response, or ripple of the supply be sure that the measuring device (differential voltmeter, digital voltmeter, or oscilloscope) is attached directly to the output terminals of the supply, as close as possible to the point where the error sensing leads are connected. Make certain that none of the output current flows through any lead lengths in series with a monitoring device, since such lead lengths can easily have an impedance of the same order of magnitude as the supply impedance and thus effectively make the measurement invalid.

When measuring power supply ripple connect either the positive or negative terminal of the supply to the chassis and ground the scope case to the same point, making certain that the scope case is not also grounded by some other means (such as a three-wire power cord). To be doubly certain that the scope is not exhibiting a ripple or transient spike that is actually not coming from the power supply, connect both scope leads simultaneously to the power supply ground terminal; no ripple or transient spike should be visible if the power supply is properly connected to the oscilloscope.

The matter of attaching monitoring devices directly to the binding

posts themselves cannot be overstressed; even one inch of #12 bus wire will have a noticeable effect on the measurements, and attaching a clip lead from a voltmeter or scope to another clip lead which is carrying output current and which in turn is connected to the binding post can result in a noticeable difference in the measurements made. One means of insuring an accurate measurement is to plug the load into the end of the five-way binding posts and then connect the voltmeter across the binding posts at the neck of the post. Wire holes are provided in the binding post and if stiff wires are placed through these holes, it is very convenient to sense the output voltage at this point.

Power Supply Loading

When connecting several pieces of equipment to the same power supply it is imperative that each load have two separate leads brought directly back to the power supply terminals if full advantage is to be taken of the low impedance of the supply and mutual coupling effects are to be avoided.

Should it be necessary to attach a load to the power supply which would cause positive current to flow into the positive power supply terminal during some portion of the operating conditions, an extra load resistance having a maximum value equal to the output voltage divided by the maximum instantaneous current which would be pumped into the supply should be connected across the supply terminal. This is necessary in order to insure continuous regulation, since the series regulating resistors must be conducting in the forward direction at all times and no external source should be allowed to add charge to the output capacitor of the power supply.

Overload Protection Circuit

If the supply is to be used in an application where the current drawn from the supply will not be essentially uniform with respect to

time, then special notice should be taken of the action of the protection circuit. Since the protection circuit is set in such a fashion that normal performance of the supply does not exist when the output current is allowed to exceed 0.5 amperes (or some lower value, depending on the setting of the maximum current knob) and since the protection circuit must necessarily be a fast-acting circuit in order to protect the series transistors, it follows that the power supply will not perform properly if the output current is allowed to exceed 0.5 amperes for even a short interval. For example, if the load on the power supply consists of a class B amplifier which is drawing peak currents in excess of 0.5 amperes, it is quite possible that the protection circuit will begin to limit the output current even though the ammeter (which reads only average current) shows something less than 0.5 amperes out. The time required for the protection circuit to begin to cut off or limit the current through the series transistors is of the order of 50 to 100 microseconds. Therefore, if a load causes current in excess of 0.5 amperes to exist for a period longer than about 50 microseconds, the supply will not provide the desired current to this load and improper operation of the load device may result. The only solution to this problem, assuming that the nature of the load device cannot be changed, lies in the use of a supply having a higher current rating, since any transistorized regulated power supply will have to have a fast protection circuit if it is to protect the series transistors at all.

Circuit Description*

Figure 1 is a block diagram of the 865, while Figure 2 is a schematic of this same supply. Notice that the layout for the schematic and the block diagram have been made to correspond almost identically in order to facilitate an understanding of the circuit.

Block Diagram - Figure 1 As shown in the block diagram, the power transformer provides power to three separate circuits- an auxiliary rectifier furnishing power for the bias and reference supply, a second auxiliary rectifier used in conjunction with the operation of the series preregulator, and the main rectifier furnishing power through a series transistor regulator to the output terminals. The error amplifier compares the output voltage with the voltage developed across the programming resistor and controls the series regulator so as to maintain the output voltage equal to the voltage across the programming resistor.

The first auxiliary rectifier circuit produces a positive and a negative bias voltage, both referenced to the negative output bus. These bias voltages are used at various points for the operation of the main regulator loop. In addition, the negative bias voltage is used as the input to a constant current reference regulator feeding the reference diode. Remembering that the action of the main feedback loop is such as to always hold the two input potentials to the error amplifier equal, it can be seen that the voltage drop across resistor R is equal to the voltage drop across the reference diode and is therefore constant; the current through resistor R must also be constant. This constant current flowing through the programming resistor determines the supply output voltage.

The overload protection circuit is activated when the IR drops across a resistor in series with the negative output terminal reaches an adjustable threshold; at this point the series regulator in conjunction with the current limiting amplifier act as a constant current feedback loop and ~~Limits~~ the output current to a value determined by the setting of the front panel knob.

Schematic - Figure 2 - The output from the fullwave rectifier D18 - D19

develops a DC voltage across the input capacitor, C6 and C7. The output voltage is controlled by series power transistor Q8. The entire output current I_o passes through power transistor Q8 and is controlled by the base current of this transistor which in turn is controlled by the base current of Q4. Likewise the base current of Q4 is controlled by the base current of Q3. In this manner a small base current I_g controls the main output current, I_o . The ratio of a change in I_o to a change in I_g is approximately 100,000 to 1. For example, a 5 microampere change in I_g would be sufficient to cause a 0.5 amp change in the output current I_o .

Figure 2 shows the transistor differential amplifier Q1 and Q2 used to control the transistor amplifier and series output transistor. The base of Q2 is maintained at the potential of the negative output terminal while the base of Q1 is connected through the programming resistor to the positive output terminal. The differential amplifier is so arranged that proper operating conditions occur when the base potentials of Q1 and Q2 are equal. If a current is passed from the positive output terminal through the programming resistor, a voltage drop will exist between the base of Q1 and the positive output terminal which will be proportional to the current passing through this resistor. Since the base potentials of Q1 and Q2 must be equal, the output voltage will be equal to the IR drop across the programming resistor. In effect then, the differential amplifier consisting of Q1 and Q2 is comparing a reference voltage consisting of the IR drop from the positive output terminal to the base of Q1 with the output voltage. It is necessary, in order that this reference be stable, that the current flowing from the positive output terminal to the base of Q1 be constant. This is assured by transistors Q5 and Q9 which develop a constant current through the reference zener diode, D2. The voltage across D2 is constant within approximately 0.3 millivolts, and when used in conjunction with R4 and R4A pulls a con-

stant current through the programming resistor.

The reference supply, which can provide only a few milliamperes, is basically a simple emitter follower Q9 (used to obtain an intermediately regulated -15 volts source) followed by a constant current stage, Q5, used to keep the current through the zener diode D2 constant. This provides a constant voltage which in conjunction with R4 and R4A pulls a constant current through the programming resistor as previously described. To change the voltage output range of the supply, it would be necessary to change the value of R4.

The overload protection circuit involves transistors Q4, Q8, and Q10. Under normal operating conditions transistor Q10 will be saturated; the voltage from the collector of Q10 to the base of Q4 will be zero or slightly negative and no current will flow through D9 and D24. When the output current causes an IR drop across R19 sufficient to remove the negative bias on Q10, the collector voltage on Q10 becomes more negative with the result that diodes D10 and D24 close and pull the base of Q4 more negative; this in turn causes the base of Q8 to become more positive, thereby limiting the output current. In this manner, the supply transfers from a constant voltage operation to a constant current operation, and the output current is limited to a level such that no damage will result to the series transistors or any other components in the power supply.

Transistors Q6 and Q7 together with their associated diodes and resistors act as preregulators for the main series transistors, thereby reducing the ripple input to the collector of Q8 and preventing the maximum dissipation in any power transistor from reaching a value which might lead to its damage. Q6 will act in such a way as to maintain approximately 2.5 volts across Q8, and Q7 acts in a similar fashion with respect to Q6.

Sympton: Excessive ripple, minimum voltage output greater than 2.0 volts.

A. Check power transistor Q6, Q7, and Q8 with an ohmmeter to see whether they are shorted. One quick method of checking these power transistors is to use an ordinary 20,000 ohms/volt multimeter such as the Triplet Type 630-T. Resistance measurements can be made between the emitter, collector and base of a power transistor. When using the Triplet multimeter (and many other multimeters) for resistance measurements, the lead from the terminal marked positive is actually a negative source. The following table may aid in checking power transistors with an ohmmeter.

Emitter	Base	Collector	Approx Resistance
+	-		5
-	+		10,000
-		+	1,000
+		-	100
	-	+	5
	+	-	5,000

Again, the + sign indicates the use of the lead from the ohmmeter which has a positive potential, regardless of whether this is labeled as the plus or minus terminal on the ohmmeter itself. (Check the ohmmeter voltage polarity with another voltmeter before proceeding with the above measurements). It is also important to remember that the device being measured is essentially a nonlinear resistor and the ohmmeter reading will not be the same on all scales. The above chart only indicates roughly the order of magnitude of resistance measurements for typical power transistors. For more accurate checking of transistor operating characteristics, a Tektronix type 575 Transistor Curve Tracer is recommended.

B. Measure voltage across diode D2 (between terminals 1 and 20). This voltage should be between 9.2 and 9.8 volts. If not, check transistors Q5 and Q9. Also check the current (should be 20ma) through R-9 by placing a voltmeter across it. If the voltage across R9 is more than 2.2

volts, check diodes D6 and D7. There should be approximately 1.2 volts across these diodes; if this voltage is excessive either diode D6 or D7 is open.

Sympton: No output voltage

- A. Check for short across the output terminals of the supply.
- B. Check for the existence of voltage across the rectifier capacitor.
- C. Check that the constant current is operating and that there is a 10 mil current flowing from the positive terminal into the programming resistor.

Sympton: Power supply goes out of regulation after being turned on for some time.

- A. Check series transistor Q8 for excessive heating and/or excessive I_{CO} current.

Sympton: Supply draws excessive line current when turned on.

- A. Check diodes D18, D19, D20, D21, and D22.

Interchangeable Transistor Types

Transistors used in this supply are not selected, but are of a "general purpose" type. The following transistors may be used:

Q1, Q2 2N1471, 2N520A, 2N1377, 2N1378, 2N1379
2N1193

Q3, Q5 2N445A

Q4 2N1471, 2N1378, 2N1379, 2N383, TS766

Q6, Q7 2N1137A, 2N457

Q8, Q9 2N1137, 2N1137A, 2N420, 2N457

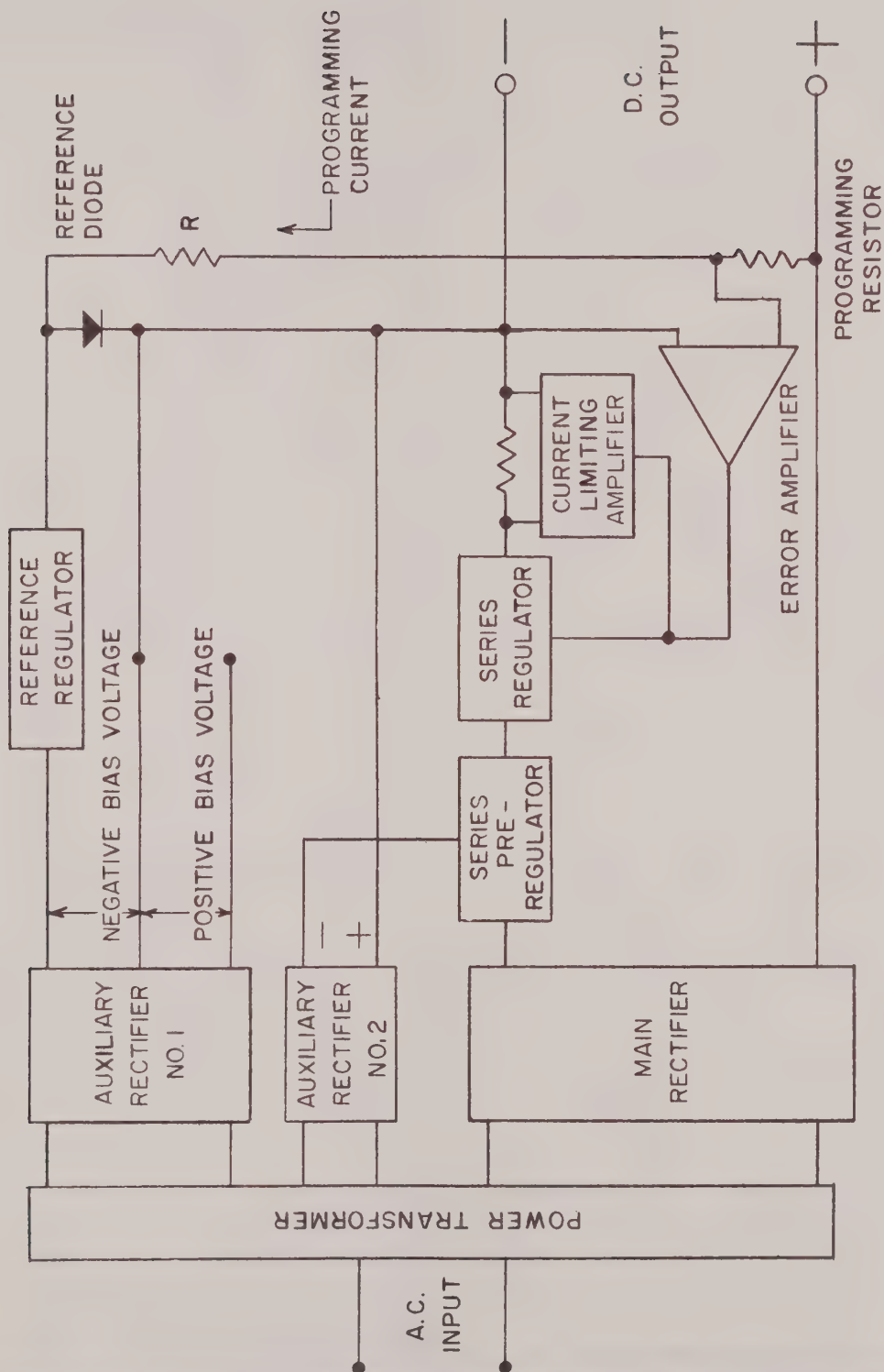
PARTS LIST 865

Circuit Symbol	Description	H-Lab. Stock No.
D18,D19,D26	Transformer H865A	TR-H865A-EP
D6,7,9,12,13,14,15,16,17,3,4, 5,23,10,24	Rectifier Ln1564	DI-1564-MO
D1	Diode F1105	DI-F1105-GI
D20,21,22	Diode PA305A	DI-320A-GI
D2	Diode PA320A	DI-2163-SE
D8	IN2163	DZ-719-HO
D25	IN719	DI-2326-Re
D11	IN2326 R.C.A.	DI-SM72-TR
C7	SM-72	CE-037-757-SP
C3	Capacitance 750uf 37V	
C5	" 5uf 50V	
C2	" 5uf 150V	
C4	" 20uf 50V	CE-050-206-SP
C6, B1	" .082 Sprague #148P82391	SP.
P-1A,B	" 490 M & D 65V	CE-065-497-SP
P-2	Potentiometer 5K - 50 dual	10032 CT
P-3	" 250 CTS Type WP	10031
P-4	" 250 CT #110	PC-250-110-CT
P-5	" 5K CTS #110	PC-250-110-CT
P-6	" 1K CTS #110	PC-1K-110-CT
S-1	Switch Trolex #212-1767-1	SW-85551-TRO
S-2	" DPDT Carling 2BLG3-73	SW-316B-73-CA
Q-1,2,4,10	Transistor 2N1471	QA-1471-ID
Q-3,5	" 2N445A	QA-445A-GT
Q-9	" 2N1137	QP-1137-BE
Q-6,7,8	" 2N1137A	QP-1137A-BE
R2	Resistor 36K 1/2W 5%	
R3	" 1.2K 1/2W	
R-4	" 970 3W	Sprague Type 242E
R-4A	" 1/2W	
R5	" 7.5K 1/2W	
R6	" 8.2K 1/2W	
R7	" 51 K 1/2"	
R8	" 750 1/2W	
R9	" 100 1/2W	
R10	" 1.8K 1/2W	
R11	" 100K 1/2W	
R12	" 1.6K 1/2W	
R13	" 51 1/2W	
R14	" 10K 1/2W	
R15	" 1.5K 10W WL	RW-1.5K-10X-WL
R16	" 10K 1/2W	
R17	" 4.3K 1/2W	
R18	" 470 1/2W	
R19	" 1.0 3W WL	RW-1-3X-WL
R20	" 100 1W A-B	
R21	" 4.7K 1/2W	
R22	" 5.1K 1/2W	
R23	" 3.3K 1/2W	
R24	" 620 2W	
R25	" 3.3 1W	

Parts List 865 (Continued)

R26	Resistor 120 CT 40W W.L.	RW-120-CT-40-817-WL
R27, 28	" 970 3W	Sprague Type 242E
R29	" 2K 2W	
R30	" 51K 1/2W	
R32	" 2K 1/2W	
R32-A	" 1/2W	

Fuse 1 amp.		
Transistor Socket Elco #3305	10166	
Mica Washer Diamond	10163	
Shoulder Washer Amatom #N1204		
Nylon	10001-1	
Fuse Holder Buss #HKP-E	10147	
Meter, Panel Hoyt (Dual)	0-40V 0-.6A.	



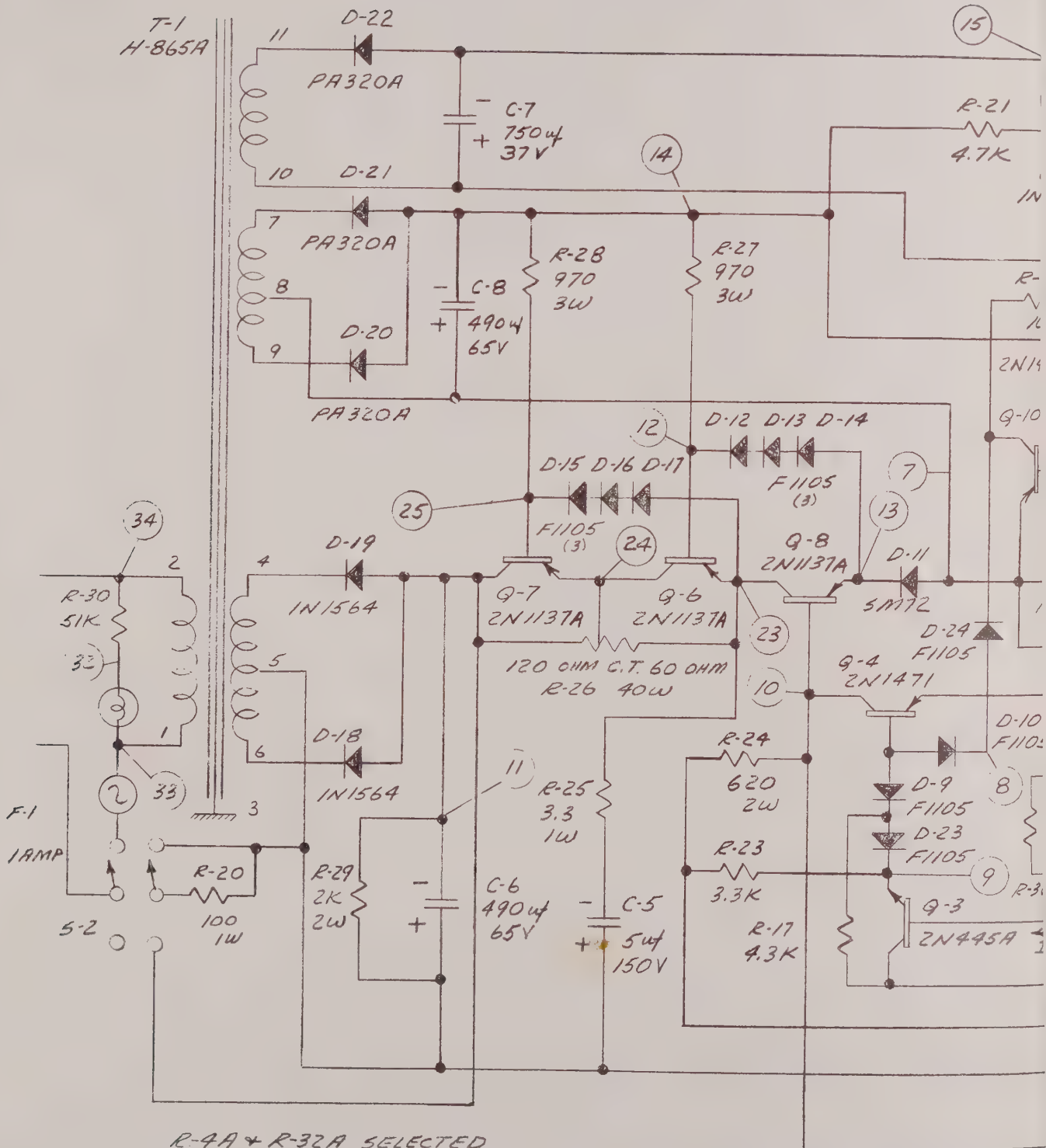
HARRISON LABORATORIES, INC.

45 INDUSTRIAL ROAD

BERKELEY HEIGHTS, N. J.

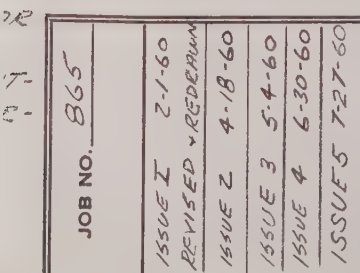
FIG-1

TITLE **MODEL 865A**
BLOCK DIAGRAM

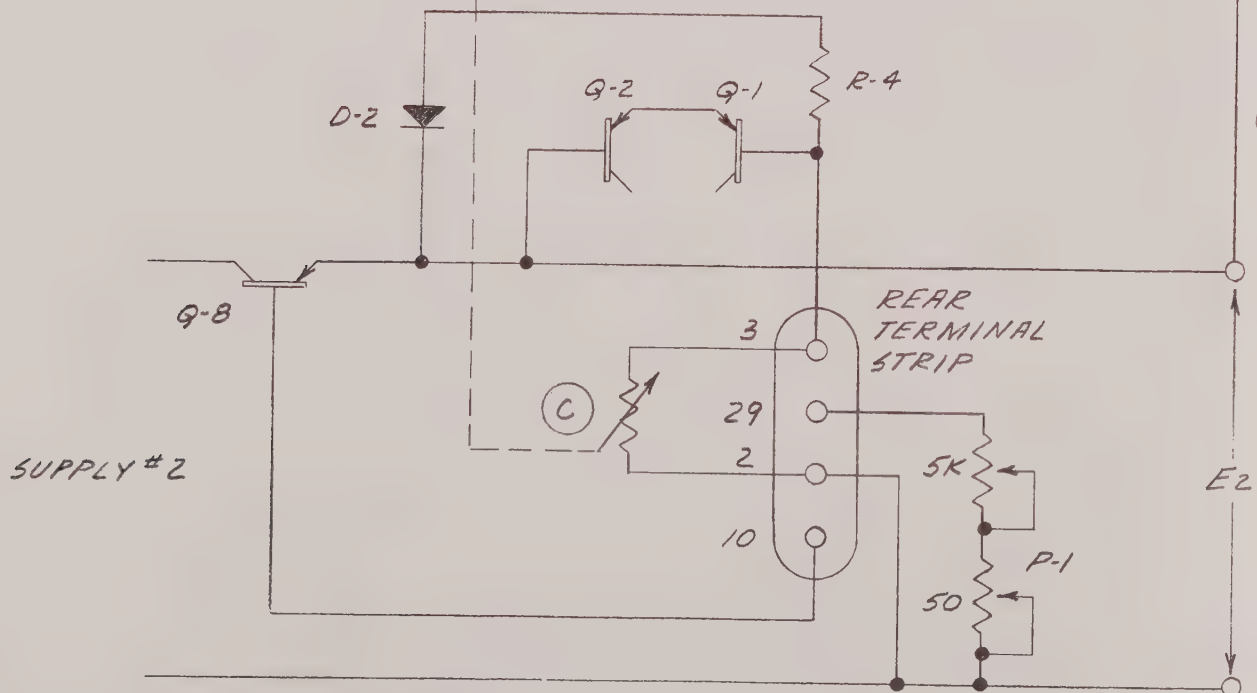
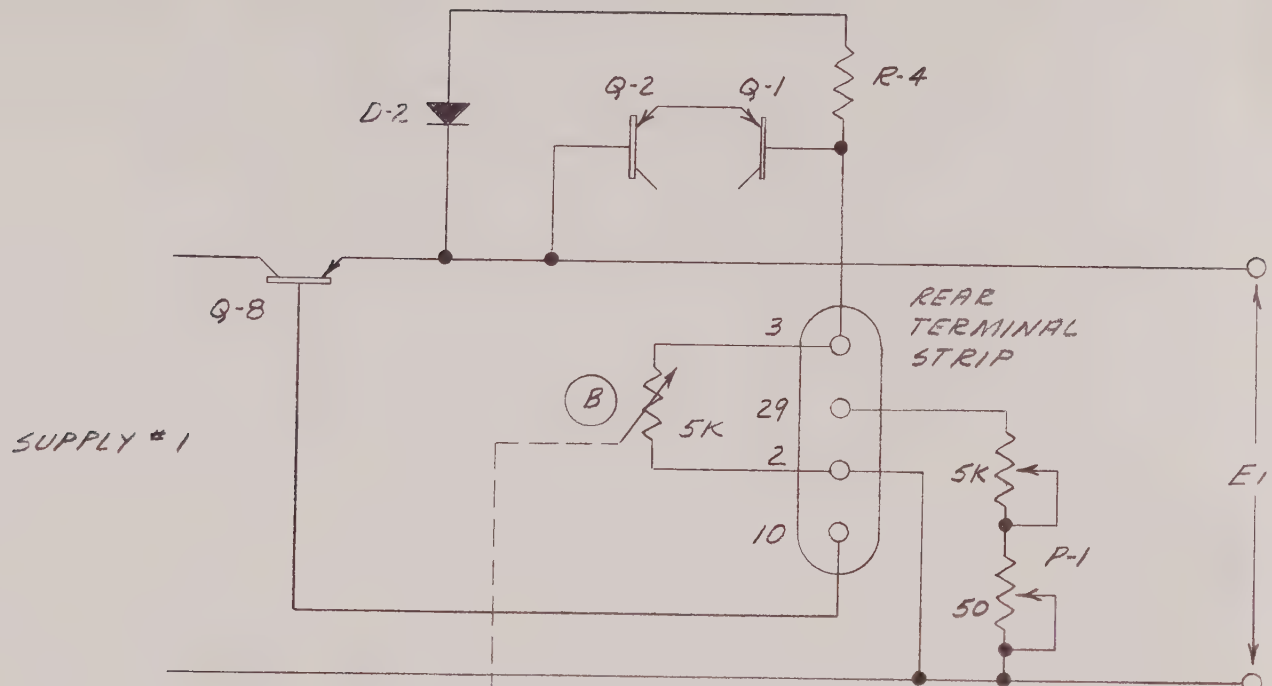


R-4A + R-32A SELECTED
 R-1, R-31 AND *27 OMITTED

PATENTS HAVE BEEN APPLIED FOR
 ON THE ABOVE CIRCUIT. LICENSE
 TO USE MUST BE OBTAINED IN WRITING
 FROM HARRISON LABORATORIES, INC.

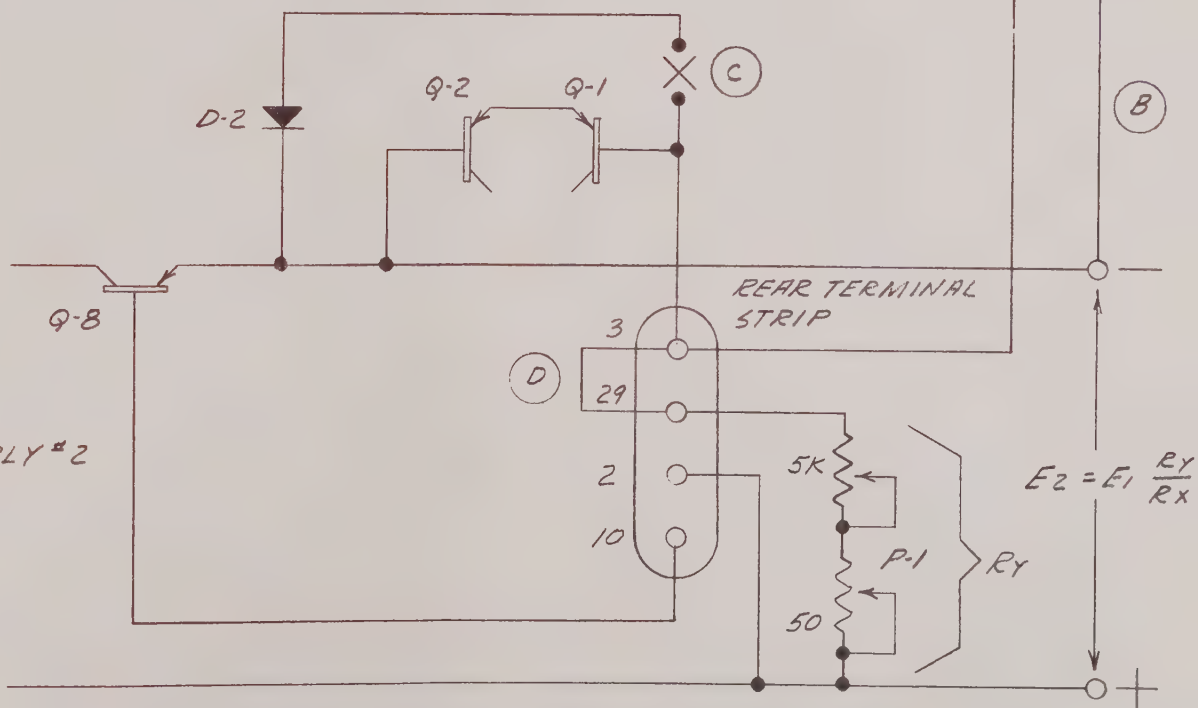
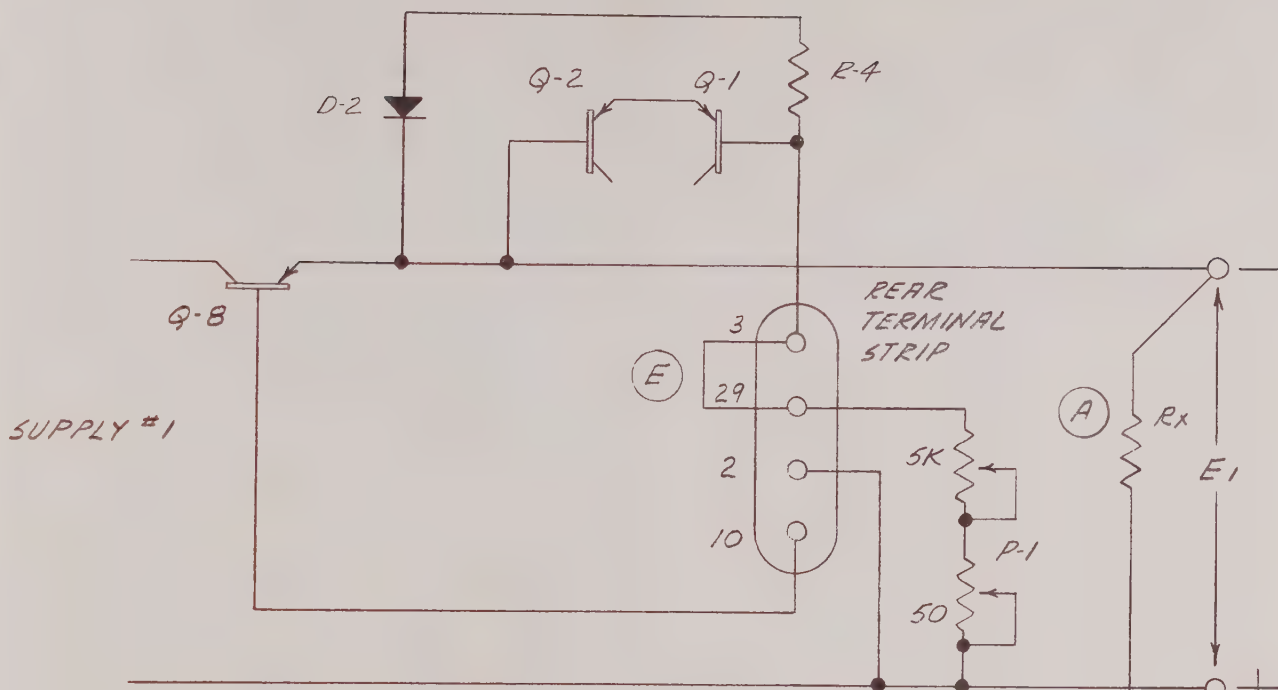


TITLE MODEL 865A
0-40 VOLTS 0-0.5 AMPS



$$E_{TOTAL} = E_1 + E_2$$

MODE 1



$$E_{TOTAL} = E_1 + E_2 = E_1 + E_1 \frac{R_Y}{R_X} = E_1 \left(1 + \frac{R_Y}{R_X} \right)$$

MODE 2

JOB NO.
855-865
DRAWN 5-12-60

SHEET 1 OF 2

HARRISON LABORATORIES, INC.

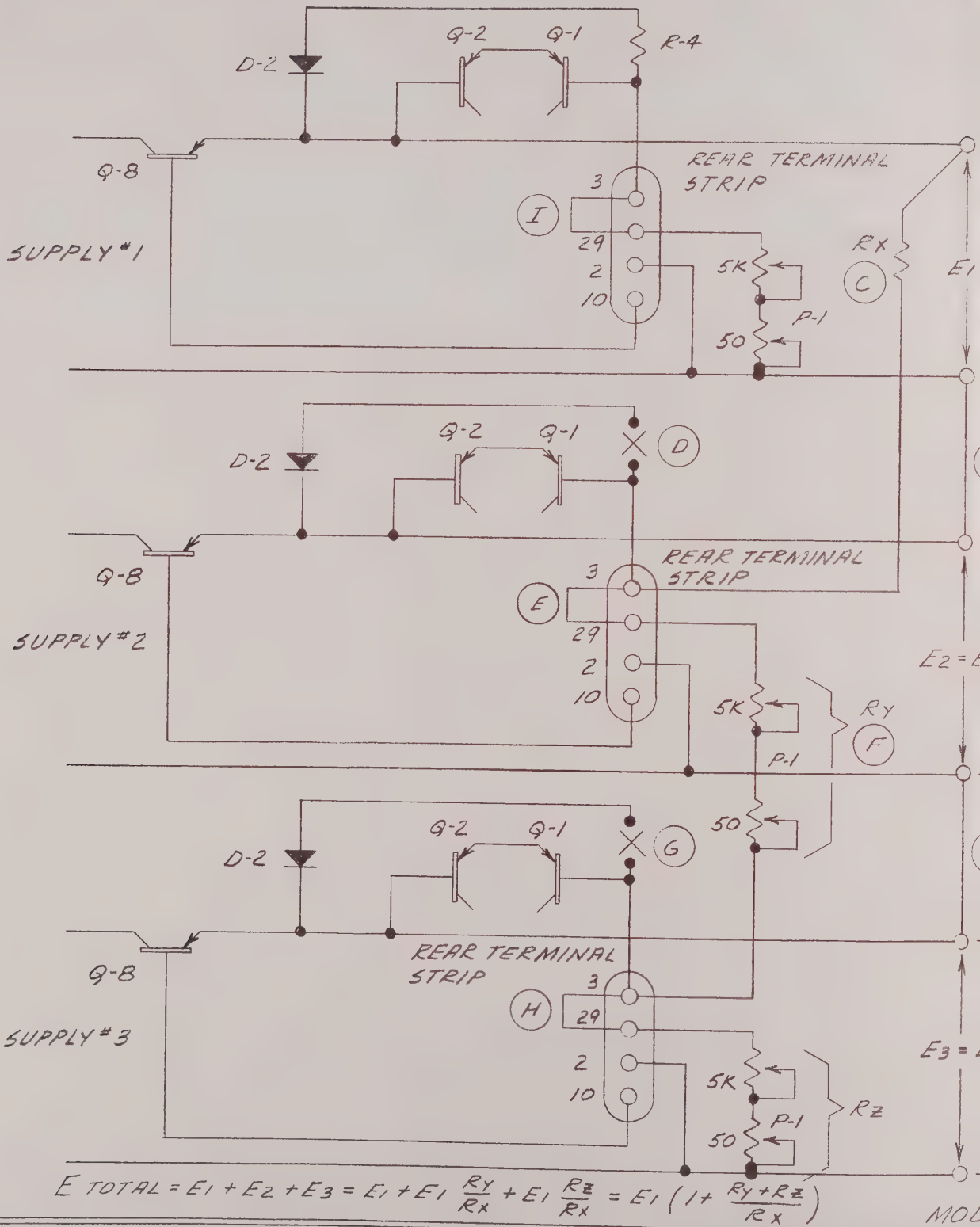
45 INDUSTRIAL ROAD

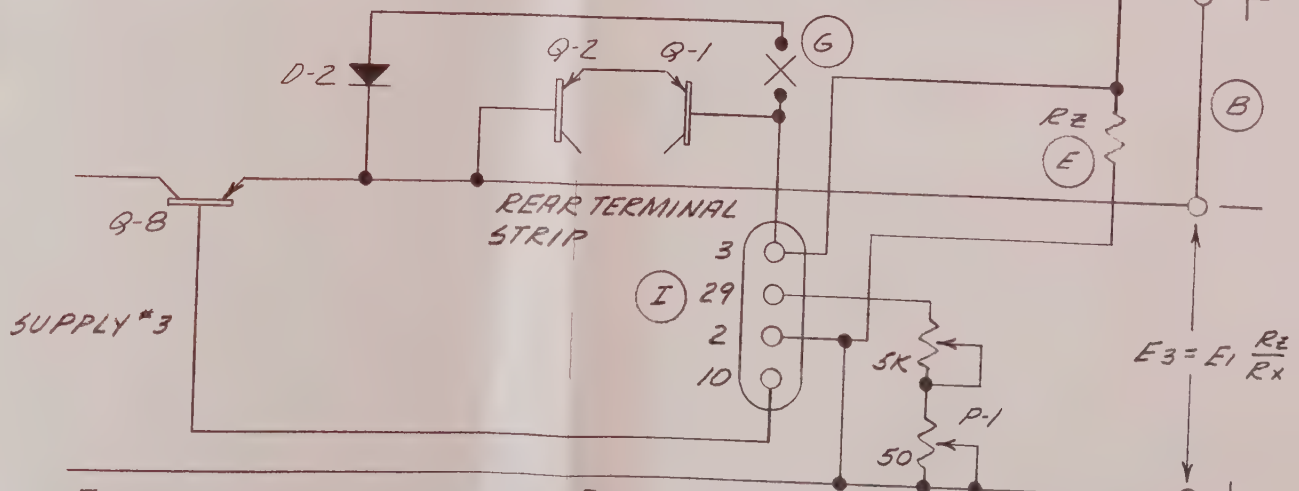
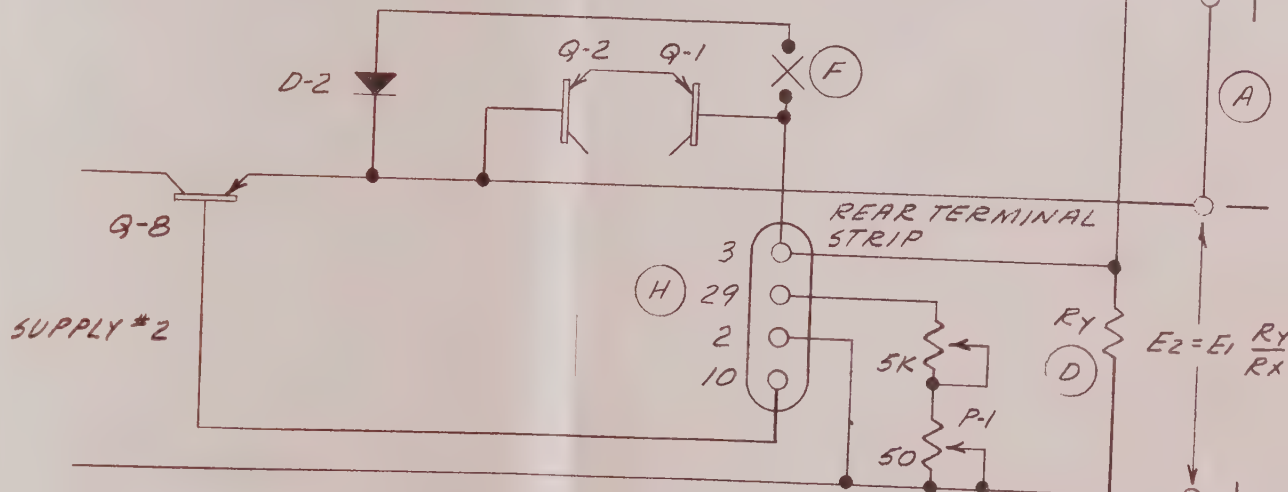
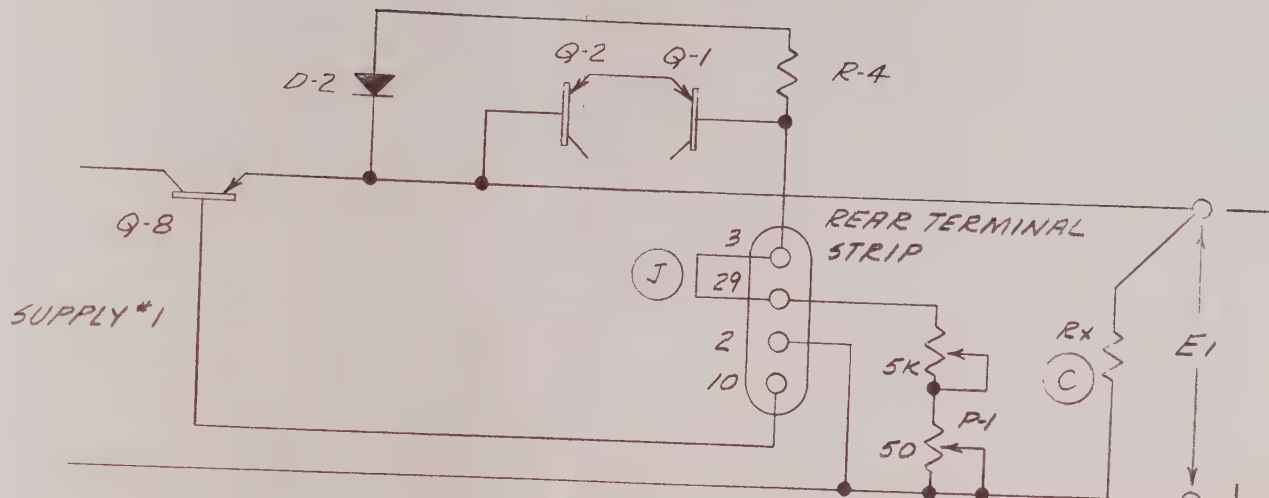
BERKELEY HEIGHTS, N. J.

FIG. 3

TITLE MODES OF SERIES

OPERATION MODEL 855-865





$$E_{TOTAL} = E_1 + E_2 + E_3 = E_1 + E_1 \frac{R_y}{R_x} + E_1 \frac{R_z}{R_x} = E_1 \left(1 + \frac{R_y + R_z}{R_x} \right) \quad \text{MODE 4}$$

JOB NO. 855-865
DRAWN 5/12-60

SHEET 2 OF 2

HARRISON LABORATORIES, INC.

45 INDUSTRIAL ROAD

BERKELEY HEIGHTS, N. J.

FIG. 3 (CONT.)

TITLE MODES OF SERIES
OPERATION MODEL 855-865

**REGULATED
POWER
SUPPLIES**

**short form
catalogue
1960**



HARRISON LABORATORIES, INC.

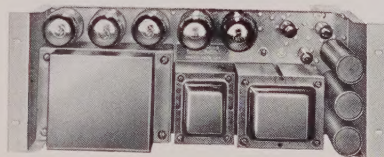
45 Industrial Road • Berkeley Heights • New Jersey



regulated vacuum tube power supplies



400D



400E

RACK-MOUNTED SUPPLIES

150-315 VOLT @ 0-1.5 AMPERES

LOAD REGULATION: Less than 30 millivolts from F.L. to N.L.

LINE REGULATION: $\pm 0.03V$ for a $\pm 10\%$ line voltage change.

RIPPLE AND NOISE: Less than 1 millivolt rms.

SPECIAL FEATURES: Only 7" high. Output voltage is variable $\pm 10\%$ about the nominal value set at factory; nominal value may be changed by changing tap on power transformer and replacing several resistors.

400D	\$595.00
400E	495.00

PLUG-IN SUPPLIES

200B 260-315 VOLT @ 1.5 AMPERES

LOAD REGULATION: Less than 30 millivolts from F.L. to N.L.

LINE REGULATION: $\pm 0.03V$ for a $\pm 10\%$ line voltage change.

RIPPLE AND NOISE: Less than 1 millivolt rms.

SPECIAL FEATURES: Separate plug-in rectifier and regulator fit into 8 3/4" high relay rack case with forced air ventilation. Supply as normally shipped is factory set for 285V out, adjustable $\pm 10\%$. Provision for jack monitoring of output voltage, current, and tube balance.

200D 150-315 VOLT @ 800 MA.

LOAD REGULATION: Less than 30 millivolts from F.L. to N.L.

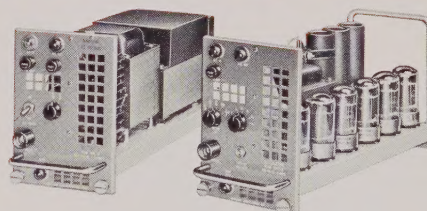
LINE REGULATION: $\pm 0.03V$ for a $\pm 10\%$ line voltage change.

RIPPLE AND NOISE: Less than 1.5 millivolts rms.

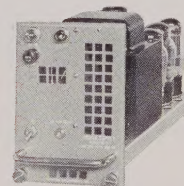
SPECIAL FEATURES: Compact plug-in supply fits into 8 3/4" high relay rack case with forced air ventilation. Output voltage is variable $\pm 10\%$ about nominal value set at factory; nominal value may be changed by changing taps on power transformer and replacing several resistors.

Price: 200B	1B Rectifier	\$255.00
	2B Regulator	365.00
200D		275.00

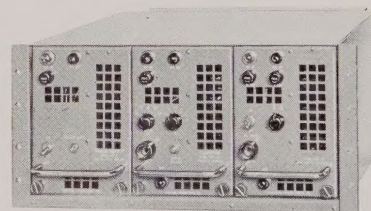
Type 10 Case (Accommodates any three of the above plug-in units) 168.00



200B



200D



Type 10 Case

THE LOWELL COMPANY
4124 Skokiana Terrace • Skokie, Ill.
ORchard 6-2063
Illinois, Indiana, Wisconsin

TOWER ENGINEERING CO.
19364 James Couzens Highway • Detroit 35, Mich.
Diamond 1-2332
Michigan

KENTRON HAWAII, LTD.
1140 Waimanu St. • Honolulu, Hawaii
Cable: "KENTRON" Phone: 53-975
Hawaii and Pacific Islands

BRIMBERG ASSOCIATES
221-5 Investment Building • Washington 5, D. C.
DEcatur 2-8000 District 7-0990
Dist. of Columbia, Maryland, Virginia, Delaware

ECKLUND ELECTRONICS SALES CO.
P. O. Box 12151 • Fort Worth, Texas
PERshing 8-9773
Texas, Oklahoma, Arkansas, Louisiana

SCIENTIFIC INSTRUMENT CO.
1460 Pennsylvania St. • Denver 3, Colorado
ALPine 5-2777
Colorado, Utah, Wyoming

INSTRUMENT ASSOCIATES
30 Park Avenue • Arlington 74, Mass.
MIsion 8-2922 TWX - ARL MASS 253
734 Asylum Avenue • Hartford 5, Conn.
CHapel 6-5686 TWX HF 266
All New England States

G. CURTIS ENGEL AND ASSOC., INC.
210 S. Broad Street • Ridgewood, N. J.
GILbert 4-1400 TWX - Ridgewood, N. J. 751
REctor 2-0001 in New York City
WALnut 2-3270 in Philadelphia
Greater N. Y. C., Long Island, New Jersey, E. Pa.

SBM ASSOCIATES, INC.
969 Clinton Avenue, South • Rochester 20, N. Y.
GRGreenfield 3-6506
9 Highland Avenue • Albany 5, N. Y.
HEmlock 8-5381
New York State (except greater N. Y. C. & Long Is.)

MOXON ELECTRONICS CORP.
489 S. Robertson Blvd. • Beverly Hills, California
BRAdshaw 2-9311 TWX-BV6744
15-W41st Avenue • San Mateo, California
FIReside 5-7961
4434 Ingraham St. • San Diego, Cal.
HUdson 8-2901
California, Nevada, Arizona

DAYTON ASSOCIATES
Suite 1318, Talbott Tower • Dayton 2, Ohio
BALdwin 3-9621
4924 Zula Avenue • Cincinnati 38, Ohio
BLACKburn 1-2349
2138 Lee Road • Cleveland 18, Ohio
TUxedo 6-3525
Ohio, W. Pennsylvania, N. Kentucky, W. Virginia

HARRISON LABORATORIES, INC.

45 INDUSTRIAL ROAD • BERKELEY HEIGHTS, NEW JERSEY • CR 3-9123

